

TRANSBOUNDARY IMPACT OF THE LIGNITE MINING ON THE GROUNDWATER RESOURCES WITHIN LUSATIAN NEISSE BASIN

Iwona ZDRALEWICZ, Mariusz ADYNKIEWICZ-PIRAGAS
Institute of Meteorology and Water Management Wrocław Branch
Regional Research Department
ul. Parkowa 30, 51-616 Wrocław, Poland
Mariusz.Adynkiewicz@imgw.pl, Badania.Regionalne@imgw.pl

The article presents a brief description of the lignite mines within Lusatian Neisse basin, whose activities affect the groundwater resources on both sides of the border state together with the characteristics of the kind and extent of the impact of these investments.

Keywords: lignite mining, groundwater resources, transboundary impact

1. INTRODUCTION

Observations for the determination of the brown coal open pits impact on groundwater state in the Polish-German borderland are carried out mainly for the purpose of assessing water resources in Lusatian Neisse basin and for the activities of the Polish-German Border Water Committee. On behalf of the Committee, Working Group W-1 is responsible for matters relating to hydrology and hydrogeology. The aims of the studies, carried out by the Working Group W-1, are transboundary impact assessment of brown coal mines, among others. On the Polish side, the Institute of Meteorology and Water Management Wrocław Branch (IMGW) and PGE KWB Turów S.A. are responsible for the measurements of groundwater level. The scheme of the Polish-Czech cooperation is similar, all problems referring to lignite opencast Turów impact on groundwater are discussed at the sessions of Working Group for Hydrology, Hydrogeology and Flood Protection on Boundary Water (HyP).

Current state and trends of groundwater level, in different aquifers in the area which are under the influence of lignite opencast mines, are assessed on the basis of joint monitoring measurements carried out by both Polish and German

side. The first measurements of groundwater level for the Polish-German Border Water Committee were carried out in March 1985 in the Jänschwalde mine impact area (Strzegów – Sadzarzewice neighbourhood) in 12 observation wells sponsored by German side.

In the 90s, it was found necessary to elaborate and standardize the documentation of groundwater observation network at the meetings of the Working Group. The documentation completed in 1999 contained a detailed list and description of the Polish and German observation points, where the measurements of the groundwater level depth were carried out during the previous years. The location of the new monitoring networks was also proposed and agreed in the areas of the other open pit lignite mines. Joint Polish-German measurements are done two times a year in all areas of brown coal mines placed near Polish-German border, and Polish-Czech groundwater level observations are executed in the Turów mine area. Additionally, each side performs measurements with a higher frequency. The results of the measurements are subject to an annual analysis at the meetings of the Working Group W-1, and the common settlements are reported to the Polish-German Border Water Committee. Furthermore, seminars take place every few years bringing together hydrogeologists, who discuss the problematic aspects of the lignite open pits' influence on the groundwater resources with particular emphasis on transborder impacts.

2. CHARACTERISTIC OF RESEARCH AREA

The brown coal exploitation carried out in one Polish (Turów) and four German (Jänschwalde, Cottbus-Nord, Nochten and Reichwalde) opencast mines and reclamation of German Berzdorf mine affect water resources within Lusatian Neisse basin. The most northern area is under the influence of the operation carried out in the Jänschwalde and Cottbus-Nord mines. The first one is located directly on the Polish-German border. The drainage of the future mine area began in 1972, removing overburden in 1974, whereas the beginning of run-of-mine coal extraction took place in 1976. The strip mining was initially moving to a southern direction, whereas since the early eighties exploitation front has changed direction and began to move north-east, toward Lusatian Neisse valley.

In 1993, the pit reached the river near Briesnig. From then on, the operation has been carried out northerly along the Lusatian Neisse. In Jänschwalde deposit, overburden thickness is from 40 to 95 m and the seam to be mined is about 10 to 12 metres thick. In 2008, the volume of the removed overburden was 143 million m³ and the annual mass of extracted coal was 13 million tonnes. In Cottbus-Nord opencast mine, located on the west side of the Jänschwalde mine, seam lies at a depth of 32 to 45 metres below terrain surface and is from 8 to 10 metres thick. The terrain drainage has been carried out since

1977 and the beginning of coal extraction took place in 1981. The Cottbus-Nord mine has an annual mining output of approx. 4 million tonnes of lignite, while the removed overburden is approx. 18 million tonnes. The exploitation front is moving to a north-westerly direction. The mine is entirely located within the Spree basin, however, the generated together with Jänschwalde opencast mine very deep depression cone has also affected the water conditions on Polish territory. Moving south along the German-Polish border, German opencast mines - Reichwalde and Nochten - are the next two objects which are located close to each other. The Nochten mine extends to the south-west of Weißwasser. Dewatering of deposit was started in 1960, and coal has been exploited since 1973. Overburden thickness is about 65 to 100 meters. Lignite lies in two seams. The II Lusatian seam thickness varies from 9 to 15, whereas the I Lusatian seam is 2-5 meters thick. In the Nochten opencast mine, an annual output (2008) was estimated at 18 million tonnes of lignite, and the amount of the removed overburden was 131 million m³. The planned closedown of lignite exploitation is planned for the year 2030. The Reichwalde opencast mine is situated in the south-east of the village Weißwasser. Mining activity at the mine started in 1980, and seven years later first lignite began to be extracted. Technical possibilities of the mine devices allow to extract 12 million tonnes of lignite and remove 70 million tonnes of overburden. Exploited seam is 9-12 meters thick and located at a depth of about 85 meters below the surface. From October 1999 to April 2010, the lignite exploitation had not been carried out at this object.

Despite the interruption, for the technical reason, the deposit must be kept free from water. Restart of the mine was in April 2010, while the end of extraction is planned for the year 2047. The next region of transborder lignite mining impact is situated in the south of Zgorzelec. At the Berzdorf opencast mine, the lignite extraction began in the XIX century (from 1835), initially under the earth. Then, since 1919 it has operated again as an opencast mine. The total mined lignite amount was about 318 million tonnes, while the removed overburden was 680 million m³. Since 1997, only land rehabilitation has been implemented while preparing the pit for the filling with water, was launched in 2003.

The time of flooding will depend on the quantity of surface water on Lusatian Neisse, which can be delivered into the pit. The amount of water which could be intaken from Neisse to pit is 50% of the difference between current flow and the border flow. Maximum water volume of the abstraction is limited by the capacity of inlet. Water intake is also carried out from the Pließnitz – left-bank tributary of the Lusatian Neisse. By the end of 2009, water intake volume was about 215 million m³ of water from the Lusatian Neisse [7]. The last characterized area of the transboundary impact of lignite mining is Bogatynia region, where the lignite deposit is now being operated by PGE KWB Turów S.A. The first lignite abstraction as an agricultural fertilizer, took place in the

vicinity of Zatonie in 1740, whereas the first underground mine was established in Opolno Zdrój in 1802 [3]. The intensification of the extraction of lignite took place in the second half of the XIX century, along with a rapid industrial development. At the end of the nineteenth century, the first power plant came into existence, whereas at the beginning of the next century, entire industrial complex "Hirszfelde" was created [4]. Turów power plant was put into operation in 1965, and year after that the opencast mine was able to extract 17 million m³ of lignite. In the 80s, two open pits namely Turów I and Turów II were transformed into one working. Subsequently, the southern part of lignite deposit called Turów III started to exist [8].

The next stage of the Turów opencast mine development was its commercialization and transformation in 2000 into a limited company [5]. By 1st November 2007, the Turów opencast mine had had an output of about 826 million tonnes of lignite, about 801 million tonnes of overburden was taken off. Currently, the pit area is approximately 24 km² and its depth is 205 m.

In the neighbourhood of Zittau, the Olbersdorf opencast used to exist. It was reclaimed in 1991. Reclamation of the mine led to the creation of water reservoir Olbersdorfer See (area 60 ha). The surrounding recultivated ground had become recreational area. After filling the pit with water, the reconstruction of the groundwater resources in aquifers in the area of reservoir took place and the state of groundwater can be described as stationary.

3. RESEARCH RESULTS AND DISCUSSION

In the area of the Jänschwalde and Cottbus-Nord open cast mines, monitoring results do not indicate the reduction of the groundwater level in aquifers above the lignite seams. Groundwater surface is corresponding to the topography. Depression cone spreading in the Quaternary multiaquifer formation and in the Tertiary overcoal aquifer has been stopped by sealing wall, which reaches low permeable Tertiary sediments.

Only at the observation points on the plateau, the slightly trend of declining water table (up to about 3 m during the past 25 years) is noticeable. It cannot be determined whether it is caused by water infiltration to dehydrated Tertiary aquifers or because of hydrometeorological situation.

The German hydrogeologists have compared the measurement data to the data from reference observation points (allowing the observation of the same aquifer, which are not under the influence of the opencast mine). They found the same systematic lowering of the water table in reference points, which was explained by the climate change. However, lignite mining has led to the occurrence of an extensive depression cone with a depth of 50 meters in the Tertiary between-coal (MW) and undercoal (WB) aquifers on the Polish side as well.

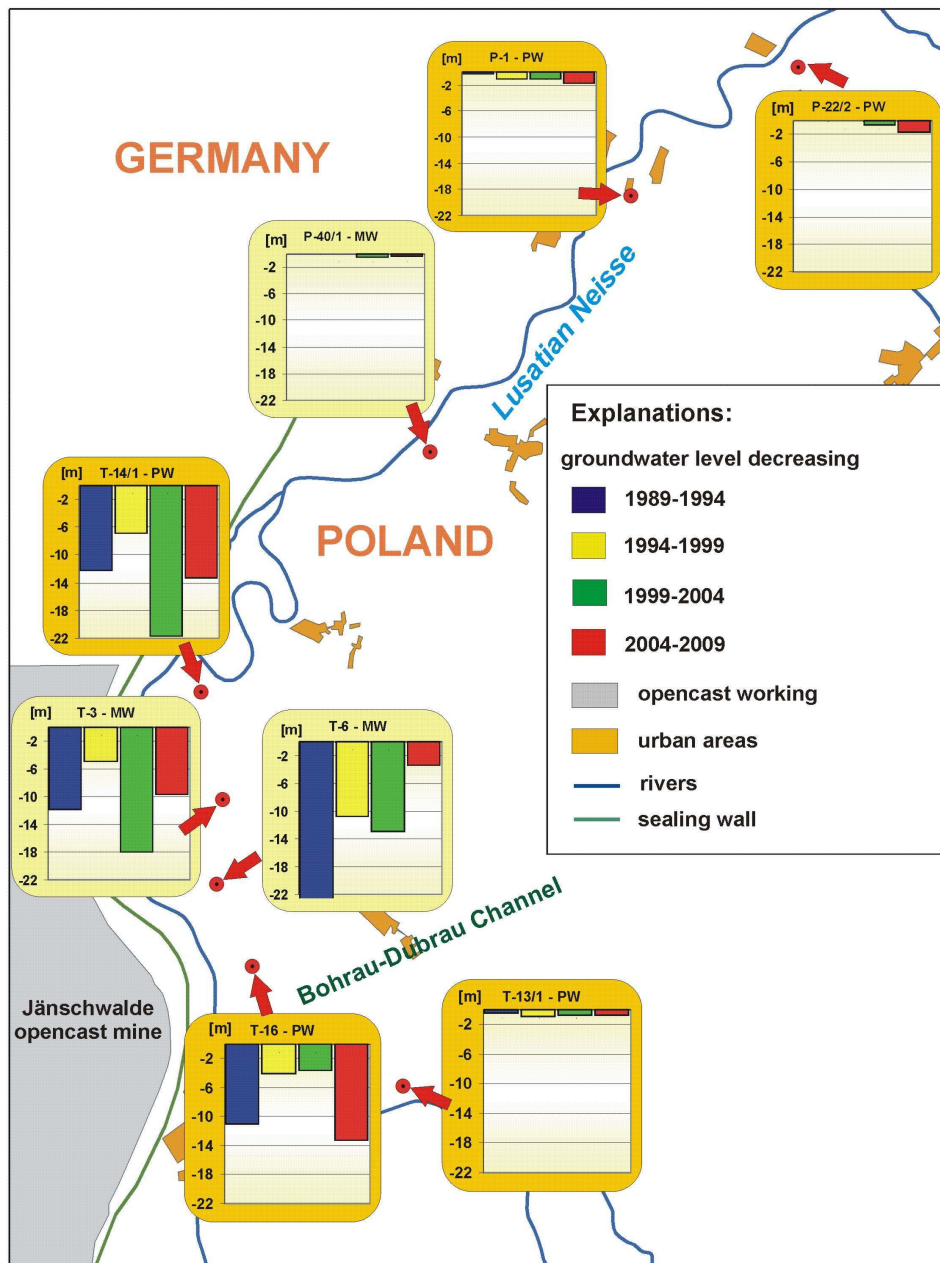


Fig. 1. Decreasing of the water level in the monitoring points enabled the observation of between-coal (MW) and undercoal (PW) aquifers during five-year periods (from 1989) in the Jänschwalde opencast mine

Figure 1 shows that the greatest reduction of water level occurred in the southern and central part of the research area. The decrease of water level during the past five years, is intense at observation point T14 /1 (PW) which is located in the front of the current mining as well as at T-16 (PW), which is next to the recultivated area. The biggest decline, during five-year periods, was recorded at point T-6, where in the years 1989-1994 the water level had fallen more than 22 meters. At the observation points P-1 and P22/2, in the last five-year period (2004-2009), lowering the water level has been intensified, in connection with moving of the lignite exploitation front in a northerly direction. In the most southerly located point P-13/1, only a slight decrease of water level is noticeable, which is associated with the occurrence of a very deep erosion Dubrau-Bohrau channel filled with impermeable sediments protecting the south area from the negative impact of the mine, which is located between the observation point and opencast mine.

The location of monitoring points along the Lusatian Neisse makes it difficult to carry out a hydrogeological analysis of the situation. Therefore, the assessment of the depression cone extent can be only done if based on the use of numerical modelling, whose results showed that depression cone, in the Tertiary between-coal and undercoal aquifers, has an area of 28 km² [1].

The impact of closing down the dewatering well barriers in the east side of mine at the monitoring points situated in the southern part of the research area is currently invisible. The process began in September 2009. Every year, the barrier wells with a length of 200 meters will be shut down. The hydrologic and hydrogeologic situation in this region will probably continue changing, because of established by Enea S.A. and KWB "Konin" in Kleczew S.A. the Energy and Mining Company plans to extract lignite in the region of Gubin and Brody municipalities and construct a power plant as well. In the case of municipal authorities' approval for the project, the formalities for design and preparatory work will last at least 10 years. The elevated object will require the construction of the sealing wall and devatering of the deposit. In addition, the German side is also planning a new investment. The application for extraction lignite license in the Jänschalde-Nord opencast mine has been submitted. Lignite deposit, at the new opencast mine, is estimated at around 250 million tonnes, while at the "old" Jänschalde mine about 160 million tonnes for extraction is left. Operating start is planned in 2025, that is after the completion of the lignite extraction in the Jänschalde mine. New investment's opportunities will affect the water relations in this area to a greater extent. The German side believes that the impact of the Jänschalde-Nord mine rising, will not affect greatly the groundwater at Polish side, because of the fact that special devices that enable to build the sealing wall with a depth of 120 meters, which will protect the middle-coal and undercoal aquifer from dehydration, are under construction.

The Nochten (Pic. 1) and Reichwalde opencast mines are situated quite far from the Polish-German border and the existing pit contour has not reached Lusatian Neisse basin. However, the results of monitoring, conducted since 1997, show a slow decline of water level (to 3 meters) in Tertiary monitoring points on Polish territory (Fig. 2).

Since 2007 the stabilization of water level has been noticeable because of the shutting down the dewatering wells barriers at the east side of mine which started in 2005, whereas the mining front has begun to move in a north-westerly direction. In connection with the restart of the Reichwalde opencast mine in April 2010 and plans for lignite extraction at this object in the direction of the German-Polish border, this trend may change. On the other hand, purely the meteorological and hydrological situation in the catchment has an impact on the fluctuation of the Quaternary groundwater.

In the area of influence of the Berzdorf opencast mine, in the framework of the Working Group W-1 activities, groundwater monitoring points have not been pointed on the Polish side, because of technical reasons. Therefore, the impact of the operation carried out at opencast mine on the groundwater resources of Polish territory has not been known. The area of lignite extraction is located within the fault block depression which is surrounded by crystalline rock outcrops. They reduce the spreading of the depression cone whose area was estimated in 1993 at about 14 km². [2].

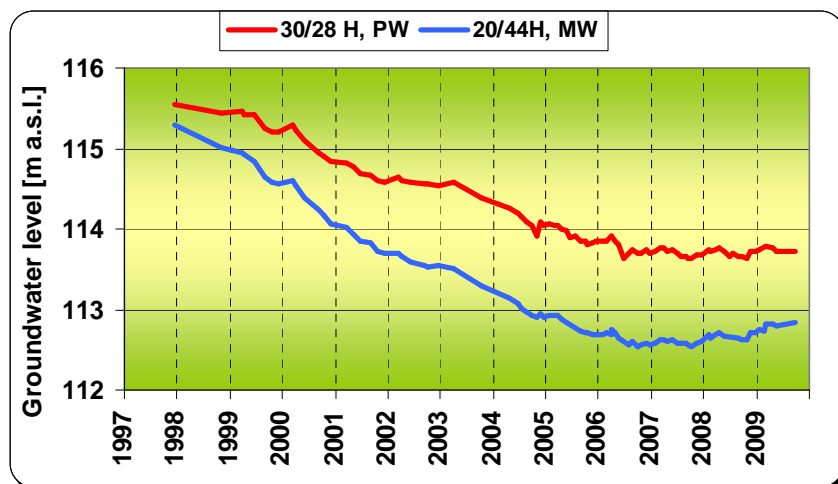


Fig. 2. Water level changes in the monitoring points 30/28H (undercoal aquifer - PW) and 20/44H (between-coal aquifer - MW)



Pic. 1. Nochten opencast mine

In order to determine the impact of filling of the post-mining pit with water on the groundwater state, the Institute of Meteorology and Water Management Wrocław Branch made three observation points in Koźlice in 2003, and the next 3 points in 2007 (regular measurements from February 2008) in Osiek Łużycki.

During pit flooding, an increase of the groundwater level in Tertiary dewatering aquifer was expected. Sealing wall situated between the pit and the Lusatian Neisse protects overcoal water on the Polish side of the border. However, in the middle-coal Tertiary dewatered aquifer, which may be observed in point PB-2, the rising trend of water level has been noticeable since December 2004. The trend is confirmed by the results from the point PB-5 (Osiek Łużycki) (Fig. 3).

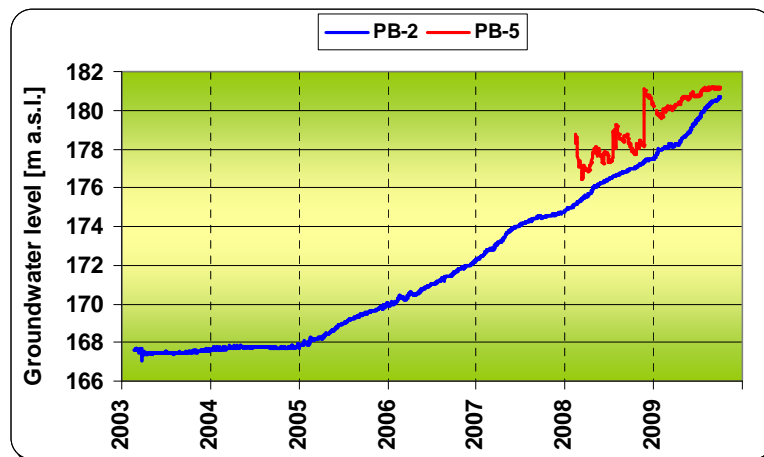


Fig. 3. Water level changes in the monitoring points PB-2 and PB-5

In the region of the Polish Turow lignite mine, 300 monitoring points are located [8]. In some of them groundwater level measurements are carried out in the framework of the activities undertaken by the Working Group W-1 and HyP. On the German side, the number of measurement points is similar. The lignite extracting site transfer to the south-west part of the opencast mine and setting up the internal dump caused the rising of water table. It can be observed on the Polish territory between the pit and the Lusatian Neisse and in Germany in the area ranging from a few hundred meters to about 2 km [6]. Depression cone progress is mainly observed in the southern part of the mine's forefield. Its extent reached south-eastern border of Zittau Basin. This border is situated on the Polish territory so the depression cone does not endanger the Czech side [8].

4. CONCLUSIONS

- The measurement results of the groundwater level along the Polish-German border indicate the existence of the transborder impacts of lignite mining on the groundwater resource
- The places of transboundary impacts are as follows:
 - Area around Strzegów (south of Gubin) which is under the influence of the German Jänschwalde lignite opencast mine. Decreasing of the water table in undercoal and middle-coal aquifers exceeded 50 meters.
 - Area around Przewóz which is under the influence of German Nochten and Reichwalde opencast lignite mines. Lowering of the water table in Tertiary piezometers on the Polish side does not exceed 3 meters.
 - Area situated at the height of flooded post-mined pit (south of Zgorzelec). Measuring points on the Polish side were sited during the recultivation of the mine. In the middle-coal tertiary aquifer, the water level has been rising by approximately 13 meters during the past five years.
 - Area around the Turów mine, where on the western side of the pit the restoration of the groundwater resources is observed and progress of the depression cone is noticeable mainly on the southern forefield of the opencast mine.
- The current impact of lignite mining on the quantitative state of groundwater as well as the plans for new projects show the need for carrying on the performed observation and analysis.

REFERENCES

1. Dubicka A., Kryza .J.: *Zastosowanie metody modelowania numerycznego do oceny wpływu odwodnień górniczych na wody podziemne w rejonie kopalni Jänschwalde*. Meteorologia, Hydrologia, Ochrona Środowiska kierunki

- badań i problemy. Instytut Meteorologii i Gospodarki Wodnej. Warszawa, 2008, 98-104. (In Polish).
2. *Kraftwerke und Tagebaue beiderseits der Deutsch-Polnischen Grenze, Elektrownie i kopalnie po obu stronach granicy polsko-niemieckiej*. Polsko-Niemiecka Komisja ds. Współpracy Sąsiedzkiej w Dziedzinie Ochrony Środowiska, Berlin/Warszawa, 1995. (In German and Polish).
 3. Holinka Z.: *Historia węglem pisana cz.1*. BOT Górnictwo i Energetyka nr 4, Biuletyn Turowa, Dodatek do miesięcznika grupy BOT, 2007, 6. (In Polish).
 4. Holinka Z.: *Historia węglem pisana cz. 2*. BOT Górnictwo i Energetyka nr 5, Biuletyn Turowa, Dodatek do miesięcznika grupy BOT, 2007a, 7 (In Polish).
 5. Holinka Z.: *Historia węglem pisana cz. 3*. BOT Górnictwo i Energetyka nr 6, Biuletyn Turowa, Dodatek do miesięcznika grupy BOT, 2007b, 8 (In Polish).
 6. Marek Z.: *Przebieg zmian zalegania zwierciadła wody po obu stronach granicy od początku wspólnych pomiarów do stanu z 2009 roku włącznie w obszarach oddziaływania Kopalni Turów*. Referat na seminarium: Oddziaływanie na środowisko niemieckich i polskiej kopalni węgla brunatnego. Krauschwitz, 06-07.10.2009. (In Polish).
 7. *Monitoring Nisy Łużyckiej. Część polska. Raport I-XII 2009 r.* Wrocław, 2010. (In Polish).
 8. Wilk Z. (RED.): *Hydrogeologia polskich złóż kopalni i problemy wodne górnictwa. Tom 1*. Akademia Górniczo-Hutnicza Uczelniane Wydawnictwa Naukowo-Dydaktyczne, Kraków 2003. (In Polish).

TRANSGRANICZNE ODDZIAŁYWANIE GÓRNICICTWA WĘGLA
BRUNATNEGO NA ZASOBY WÓD PODZIEMNYCH W ZLEWNI NISY
ŁUŻYCKIEJ

Streszczenie

W artykule przedstawiono krótki opis kopalń węgla brunatnego w zlewni Nisy Łużyckiej, których działalność wpływa na zasoby wód podziemnych po obu stronach granicy państwowej wraz z charakterystyką rodzaju i stopnia oddziaływania tych inwestycji.